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A GUIDE FOR THE SELECTION OF SUPERIOR TREES IN THE NORTHERN ROCKY MOUNTAINS

by

The Forest Genetics
Steering Committee

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UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE

NORTHERN ROCKY MOUNTAIN FOREST
AND RANGE EXPERIMENT STATION

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The Forest Genetics Steering Committee is an informal group composed of representatives from the following organizations:

U. S. Department of Agriculture
  Bureau of Entomology and Plant Quarantine
    Blister Rust Control, Northwestern Project, Spokane, Washington
    Forest Insect Laboratory, Coeur d'Alene, Idaho
  Bureau of Plant Industry, Soils, and Agricultural Engineering
    Division of Forest Pathology, Missoula, Montana
  Forest Service
    Northern Rocky Mountain Forest and Range Experiment Station, Missoula, Montana
    Northern Region, Division of Timber Management, Missoula, Montana
Montana State University
  School of Forestry, Missoula, Montana
University of Idaho
  School of Forestry, Moscow, Idaho
Washington State College, Pullman, Washington
  Department of Agronomy
  Department of Horticulture
  Division of Forestry and Range Management

The purpose of the Committee is to stimulate interest in forest genetics and to coordinate research in this field within the region where the member institutions operate. Although this report was reproduced by the Northern Rocky Mountain Forest and Range Experiment Station, it is the work of the entire Committee.

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Photograph on cover. The photograph on the cover shows one of the apparently blister rust resistant western white pine trees which is being employed for controlled cross-pollination. (See footnote 2, page 6.) Photograph by Northwestern Project, Blister Rust Control.

A GUIDE FOR SELECTION OF SUPERIOR TREES IN THE NORTHERN ROCKY MOUNTAINS

By
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Improvement of domesticated plants and animals through selection and controlled breeding of superior individuals has been practiced for many years. Most of our present-day varieties of agricultural plants such as wheat, corn, tomatoes, and potatoes are results of selection and controlled breeding. Similarly, poultry, cattle, and other domestic livestock have been greatly improved. Selective breeding and controlled crossing have resulted in improvements in almost every conceivable characteristic; for example, growth rate, yield, size, edibility, strength, resistance to parasites, age at maturity, frost hardiness, and storage qualities. Although hybrid corn is undoubtedly the most spectacular example of widespread application of genetics principles, it is only one of the many instances that exist in agriculture, horticulture, and animal breeding.

Despite the long continued and widespread application of principles of heredity in plant and animal breeding, only recently has an active interest developed in improvement of forest trees for wood production. In the past, a considerable number of trees have been modified by selection and breeding for such purposes as aesthetics, and fruit and latex production. The russet-leaved Schwedler maple is an example of an ornamental variety of Acer platanoides, the Norway maple. Commercially produced varieties of apples are selected mutants. But bettering trees for timber production by controlled breeding has received comparatively little attention. Abundant virgin stands have tended to obscure the need for improvement in the northern Rocky Mountain region. However, with diminishing natural stands of timber and with the increase in artificial reforestation programs, the opportunities for growing improved strains of trees have come into the foreground.

Trees growing in natural stands vary in their ability to yield high quality forest products. It is this variation that makes improvement possible. For example, some trees grow rapidly or have fine branches which tend to prune easily, while others, though living under similar conditions, grow slowly or possess coarse branches. Some trees appear to be resistant to certain diseases and insects while others succumb to them quickly. By locating individuals that appear to be inherently superior in one or more ways, and by providing for mass production of seed from the selections, we can have better trees for planting.

The Forest Genetics Steering Committee has prepared guides for identifying superior individual trees in the northern Rocky Mountain region, and is proposing a system for recording them. The guides for selection

and method for reporting superior trees are described in this paper. They are only the first steps in a program of forest tree improvement. Eventually, progeny testing of the selected trees and development of seed orchards where certified seed for reforestation programs can be produced in quantity will be necessary.

In launching a program of the sort proposed we are faced with inadequate knowledge of the trees' genetic constitutions and the uncertainty of attempting to rate trees for inherent superiority by using visible characters. Differences in growth rate and timber quality are affected by environment as well as by inheritance. Furthermore, no sure ways exist at present for evaluating inherent ability without progeny testing. In view of the uncertainties about heritability and the influences of environment, the most logical approach is to start with trees that have good visible characters. Geneticists call these trees good phenotypes; in shop talk terms they are "phenotypically plus" or simply "plus" trees. Some of them probably cannot transmit their desirable traits and they may even prove to be genetically inferior. However, knowing that inheritance is a strong factor, and using good judgment in evaluating effects of environment, we can be reasonably sure that many of the selected trees will, upon progeny testing, prove to be good genotypes--trees with good inherent qualities.

At present, with the existing limited knowledge of what kinds and degrees of traits indicate definite superiority, only relatively general guides can be suggested. In some instances, experience will prove that the wrong traits were chosen, or that requirements were made too easy or too severe. Hence, changes in specifications may be expected from time to time.

Where To Select "Plus" Trees

1. Selections should be made from stands where the trees can be compared directly with competitors of the same species. An isolated tree generally is of doubtful value unless there are trees of similar age nearby with which the selection can be compared. However, absence of opportunity to make direct comparisons should not disqualify a tree which possesses extremely unusual characteristics. Furthermore, resistance to blister rust and several other important kinds of resistance to injury, as well as adaptability to the habitat could be detected in an isolated tree. Plantations are well suited for picking superior trees because of the uniform spacing and the even start that the trees receive. However, native origin of the trees may not be known and they may be too young to fully prove their adaptation.

2. Selection should generally be limited to trees of the size and age when they are ready for harvest. Young trees may have inherent undesirable traits which will show up later in life, whereas older trees have presumably withstood the test of time for a full rotation. Here again, trees with extremely unusual characteristics may be acceptable. White pine is an exception to the rule that choice should be limited to trees which are approaching maturity. In this instance, blister rust resistance is the paramount consideration at present. White pines which are suspected of possessing rust resistance must be young enough that they can be climbed for examination but old enough to fruit (25 to 60 years old). Christmas trees are an example of a forest product which attains economic maturity at an unusually young age.

Specifications for High-Quality Timber Trees

Traits that apply generally

Desirable traits applying to most species are listed below. The first two items, rapid growth and absence of particularly important diseases and insect damage are considered to be the most important. Ordinarily if a tree exhibits exceptional growth or resistance to injury and is at least as good as normal in regard to other traits listed, the tree should be reported. On the other hand, although the last four traits listed are less important than the first two, extreme superiority in those traits should not be overlooked. For example, if a tree possesses extremely fine branches and is at least normal or not seriously below normal in other respects, the tree may be of value and should be reported.

1. Rapid height and diameter growth. A "plus" tree should substantially excel neighbors of similar age in height and diameter. As a specific standard, it is recommended that to qualify as a "plus" tree because of rapid growth, the individual must exceed its three next biggest neighbors of the same age in the immediate vicinity by 50 percent in cubic volume. This is the standard which has been recommended for adoption in Sweden.1/

2. Evidence of resistance to injury by economically important diseases and insects, and other seriously injurious agents. Since susceptibility to some diseases and insects is known to be heritable, reject parasitized trees. Specific resistance qualities, of course, can be judged only in stands where extensive damage has occurred. Presence of rot, in which fortune and age play a large part, should not disqualify an otherwise exceptional tree. Likewise, fire scars and accidental mechanical injuries should not disqualify a selection. Resistance to wind, snow, and glaze injury should be considered as well as injury by biotic agents.

3. Straight, clean bole with little taper. Definite form class specifications would be desirable as guide lines for judging taper, but until a better idea has been gained as to what constitutes acceptable or superior taper, a more specific rule cannot be offered.

4. Narrow crown. Here again, statistical measures would be desirable to express the relation between crown width and shape in relation to tree size. However, for the present, trees should be compared with the average for the same species in that vicinity.

1/ Lindquist, Bertil. Genetics in Swedish forestry practice. The Chronica Botanica Co., Waltham, Mass. 1948. (173 pp., illus.)

5. Slender or fine branches. Coarse branches make large knots which reduce lumber quality. They should be avoided. Tendency to prune well, if the tree receives side shade, would be a desirable quality. Fine branching makes for better natural pruning. Narrow-crowned trees usually have fine branches.

6. Few limbs per whorl. Trees which have more than five or six limbs in a whorl usually should be rejected. However, more field study is needed to determine if this specification is reasonable for certain genera such as the true firs.

Traits That Apply to Individual Species.

1. White pine. Resistance to blister rust is essential. Therefore, "plus" white pine trees must not bear rust cankers, and must be growing in highly infected, unprotected stands in which infection is at least 20 years old. As has been noted earlier, selection for blister rust resistance will take precedence over the general rule that trees must be mature or nearly mature. Although blister rust resistance is the prime consideration with white pine, opportunities for discovering trees which are superior in growth and timber quality, in addition to being rust resistant, should not be overlooked.

2. Ponderosa pine. Two different kinds of ponderosa pine trees should be sought. One kind is trees which are adapted to more typical ponderosa pine habitats. "Plus" trees of this type should ordinarily fit the qualifications previously discussed under "Traits that apply generally".

   The other kind of ponderosa pine which should be sought are individuals which are adapted to growth on white pine sites. Often ponderosa pine trees which are situated on white pine habitats appear to suffer from snow injury. They probably are poorly adjusted to the coolness of the habitat and the more abundant soil moisture. If well-adjusted individual ponderosa pine could be found, they would be valuable as a substitute for white pine in places where blister rust control is not economically feasible and perhaps in places where white pine is heavily damaged by pole blight. For the initial search, good adjustment to the habitat will be the prime requirement, rather than superiority in growth, form, and other traits.

3. Western larch. This species normally exhibits several desirable traits including rapid juvenile growth, good form, fine branching, narrow crown, and a pronounced tendency to self-prune faster than other native trees. However, further improvement probably is possible, and, in addition, larch might be bettered strikingly in three specific ways as follows:

   3.1 Faster diameter growth after the first 50 to 80 years. Tentatively, it is recommended that to qualify as a "plus" tree, a growth rate of eight rings per inch at age 100 years be set as the minimum.

3.2 Resistance to dwarf mistletoe. This would be a highly desirable attribute. Resistance to dwarf mistletoe would be a good quality to establish, even though it occurred in trees which did not exhibit unusual growth for the species.

3.3 Absence of shake. Separation of the annual rings in the butt section of large larch trees is a serious defect. Absence of shake would be a good trait to develop, even if it is not associated with fast growth and mistletoe resistance.

4. Douglas-fir. In western Montana, sweep and dwarf mistletoe broming are common defects of Douglas-fir. Therefore, trees of good form and free of mistletoe that are growing in stands heavily infected with the parasite should be sought.

5. Engelmann spruce. This species, which is normally shallow-rooted and subject to windthrow, could be conspicuously bettered by establishment of a race which would exhibit greater resistance to uprooting. Resistance to attack by the common spruce gall aphid also would be desirable.

6. Lodgepole pine. Susceptibility to injury by dwarf mistletoe appears to be an outstanding weakness of this species. Therefore, resistance to dwarf mistletoe should be the first test for lodgepole pine. If such trees can be found, superiority standards for other traits need not be set high. Resistance to dwarf mistletoe infection can be judged only in stands where the parasite is epidemic.

7. Grand fir. Extreme susceptibility to heart rot keeps grand fir from attaining greater commercial importance. Resistant trees should be sought.

Specifications for "Plus" Christmas Trees

Desirable traits for Douglas-fir Christmas trees are as follows:

1. Resistance to Douglas-fir needle blight. Rhabdocline pseudotsugae seriously damages Douglas-fir Christmas trees. No Douglas-fir should be considered as a "plus" Christmas tree unless it shows a high degree of resistance to needle blight.

2. Dense branching.

3. Good needle retention. Trees that lack needles near the bole, causing what is termed "legginess" in the Christmas tree industry, should be disqualified.

4. Long, wide needles.

5. Normal crown taper. Width at base of usable portion of crown should be 35 to 40 percent of total height, with uniform taper to tip.

6. Normal branch thickness. Disqualify trees that have either excessively pliable branches or excessively stiff branches. The branches must be stiff enough to support ornaments, but not so rigid that they cannot be bent upward for compact bundling in shipment.

Selection of High-Quality Stands

Stands known to be genotypically superior would be desirable as seed collection sources. However, selection of such stands is difficult because environmental influences cannot be distinguished from hereditary factors. Evaluation of hereditary factors with any degree of certainty would require progeny testing. However, if rather open-grown stands can be found which contain many trees of superior stem or crown form, there would be some reason to suspect better-than-average hereditary tendencies, and they should be reported.

Program for Discovering and Reporting "Plus" Trees

The Forest Genetics Steering Committee requests all foresters who work in Montana, north Idaho, and northeast Washington to assist in a search for superior trees. At present no agency has the facilities to carry out a thorough search of the entire region. There is no way of predicting where a superior tree may be discovered. Hence, only through a continual search by as many qualified persons as possible can a reasonably comprehensive examination be made.

The Northern Rocky Mountain Forest and Range Experiment Station, Missoula, Montana, will act as the principal recording agency for collection of records on what are believed to be "plus" trees[2/]. The Experiment Station will designate a member of the Steering Committee to examine trees which are reported, and will make a permanent record if the conclusion after examination warrants it. Persons who desire to report exceptional trees should send their information to the Experiment Station unless it is more convenient to report to some other representative of the Steering Committee.

Descriptions of what are believed to be "plus" trees should contain information on the points listed on the next page, as well as

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2/ The Northwestern Project, Blister Rust Control, 618 Realty Building, Spokane, Washington, which is already leading a rust resistance breeding project, will continue as the primary clearing agency for resistant western white pine trees, and will take the initiative in rust resistance testing. About 65 apparently rust resistant trees have already been found and many of these are being artificially pollinated, grafted, and progeny tested. More trees, especially those that appear to be superior in other traits as well as rust resistant, are desired. Persons wishing to report white pine trees should write directly to Blister Rust Control.

any other information which the reporter believes will be useful. The standards which have been described earlier in this report should guide in judging if a tree is likely to qualify.

1. Name and address of finder
2. Location of tree
3. Land ownership
4. Species
5. Forest type
6. Situation (creek bottom, steep northerly slope, etc.)
7. Open grown or dense stand
8. Age
9. D.b.h. (give actual dimension and compare roughly with neighbors)
10. Total height (give actual dimension and compare roughly with neighbors)
11. Form and straightness of bole (describe)
12. Crown (narrow, normal, wide)
13. Fineness of branches and tendency to prune naturally (describe)
14. Number of limbs per whorl
15. Occurrence of diseases and insects. (If resistance to a particular parasite is suspected, note particularly if the parasite is or has been epidemic in the neighborhood)
16. Basis for suspecting superiority

Plans for follow-up work on superior trees are at present rather indefinite. Protection of the trees, grafting for transfer to central locations, controlled pollination for progeny testing and establishment of seed orchards would, of course, be desirable. Definite plans as to how much can be done and who will do it must wait until enough records of suitable trees have been gathered to give a basis for estimating the potentialities and the magnitude of the project. For the present, an attempt will be made to have all accepted selections grafted on a small scale, mainly for the purpose of preserving the germ plasm.

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